Control flow

Inteligencia Artificial en los Sistemas de Control Autónomo
Máster en Ciencia y Tecnología desde el Espacio

Departamento de Automática

Universidad de Alcalá
ISG

Objectives

1. Understand control flow in Python
2. Understand functions and its syntax in Python
3. Design elemental algorithms
4. Implement elemental algorithms in Python

Table of Contents

Conditions and loops

if Statements (I)

Conditional statements implement decision making

- It is based on a condition
- The result is boolean
- Remember: Identation defines the body code

```
temperature = float(input('What is the temperature?
    '))
if temperature > 70:
    print('Wear shorts.')
else:
    print('Wear long pants.')
print('Get some exercise outside.')
```

Good practice: The usage of `else` is optional, try to avoid it!

Conditions and loops

if Statements (II)

Many times decisions are not binary (true/false): `elif`

- Conditions are evaluated until first true
- If all conditions are false, then it executes `else`
- `else` is optional (try not to use it!)

elif Statement

```
if [condition1]:
    # Some code here
elif [condition2]:
    # Some other code
elif [condition3]:
    # Some other code
else:
    # More code
```

Conditions and loops

if Statements (III)

Complex if Statement

```
x = int(input("Please enter an integer: "))

if x < 0:
   x = 0
   print('Negative changes to zero')
elif x == 0:
   print('Zero')
elif x == 1:
   print('Single')
else:
   print('More')

print(x)
```

Conditions and loops

`for` Statements (I)

- Sometimes we have to repeat a task: Loops
  - Other languages iterate over a condition
  - For instance, in C: `for (i=0; i<10; i++)`
- Two loop statements in Python: `while` and `for`
- In Python, for iterates over a sequence (lists or strings)
  - In each iteration, it assigns a sequence value to a variable

for Statement example

```
list = ['cat', 'window', 'dog']

for x in list:
  print(x)
```

for Statement example

```
string = "Hello word"

for x in string:
  print(x)
```

Conditions and loops

`for` Statements (II)

Sometimes, we need to iterate over a sequence of numbers

- `range(n)`: It returns a sequence $0, ..., n-1$

`range()` example

```
for i in range(5):
  print(i)
```

Alternative notation

```
a = ['Mary', 'had', 'a']

for i in range(len(a)):
  print(i, a[i])
```

Conditions and loops

Branching statements (I)

We do not always want to iterate over the loop

- `break`: Exit the loop
- `continue`: Jump to next iteration
- `break` and `continue` are valids in loops

break use

```
for i in foo:
  # Some code
  if i == 3:
    break
  # More code
```

continue use

```
for i in foo:
  # Some code
  if i == 3:
      continue
   # More code
```

Conditions and loops

Branching statements (II)

Break example

```
number = int(input('Enter a number: '))

if number > 1:
  is_prime = True
  for divider in range(2, number):
    if number % divider == 0:
      is_prime = False
      break
else:
  is_prime = False

if is_prime:
  print('The number {0} is prime.'.format(number))
else:
  print('The number {0} not is prime.'.format(number))
```

New Python feature

- The *format* method

Conditions and loops

Branching statements (III)

What this is doing?

```
for i in range(2, 10):
    for x in range(2, i):
        if i % x == 0:
            print(i, 'equals', x, '*', i//x)
            break
        else:
            print(i, ' is prime number')
```

Conditions and loops

`pass` statements

pass: A statement that does nothing ...

- ... yes, nothing
- It is used to avoid interpreter errors
- Code blocks doing nothing

Example 1

```
# Infinite loop
# waiting an
# interrupt

while True:
  pass
```

Example 2

```
# Empty class

class MyEmptyClass:
  pass
```

Example 3

```
def initlog(*args):
  # Ignore function
  pass
```

Functions

Defining functions (I)

Function: A piece of code that can be used several times

- Lazy programmers are good programmers
- Code reuse

Functions can be used with parameters

- Define a function before using it

Function 1

```
def printHello():
  print("Hello")

printHello()
```

Function 2

```
def printTwice(string):
  print(string)
  print(string)

printTwice(string)
```

Hint: If you have to use code more than once, place it in a function

Functions

Defining functions (I)

Python functions can return values

Conversion of degrees

```
def farenheit_centigrados(x):
    """Conversion de grados Farenheit a Centigrados"""
    return (x - 32) * (5 / 9.0)


def centigrados_farenheit(x):
    """ Conversion de grados Centigrados a Farenheit"""
    return (x * 1.8)+32
```

New Python features

- The return statement

Function invocation

- centigrados_farenheit(100)
- temp = farenheit_centigrados(100)

Functions

Defining functions (II)

A function may be as complex as needed

Fibonacci series function

```
def fib(n):
    """Print a Fibonacci series up to n """
    result = [] # Declare a new list
    a, b = 0, 1
    while a < n:
        result.append(a) # Add to the list
        a, b = b, a+b
    return result
```

New Python elements:

- *docstrings*, for automatic documentation
- Adding elements to a list

Function invocation

- fib(10)

Functions

Defining functions (III)

Boring (albeit useful) fact: A function is just another variable

```
>>> fib
<function fib at 0x100677140>
>>> f = fib
>>> f(100)
0 1 1 2 3 5 8 13 21 34 55 89
>>> f
<function fib at 0x100677140>
```

Functions

Global and local variables (I)

Variable scope:

- **Global variables**: Defined outside of the functions.
  - Can be read within and outside the functions.
- **Local variables**: Defined within of a function, including *formal parameters*.
  - Invisibles outside the function.

Hint: Try to avoid global variables

Example

```
a = 5

def f():
    a = 2
    print(a) # 2
    return

f()
print(a) # 5
```

Functions

Global and local variables (III)

Example 3

```
def increase(p):
    p = p + 1
    return p

a = 1
b = increase(a)

print('a:', a)
print('b:', b)
```

Functions

Global and local variables (IV)

Examples:

Example 1

```
lista = ["Juan", "Pepe"]

def f():
    lista.pop()

print(lista)
f()
print(lista)
```

Ejemplo 2

```
lista = ["Juan", "Pepe"]

def f():
    lista = ["Maria"]

print(lista)
f()
print(lista)
```

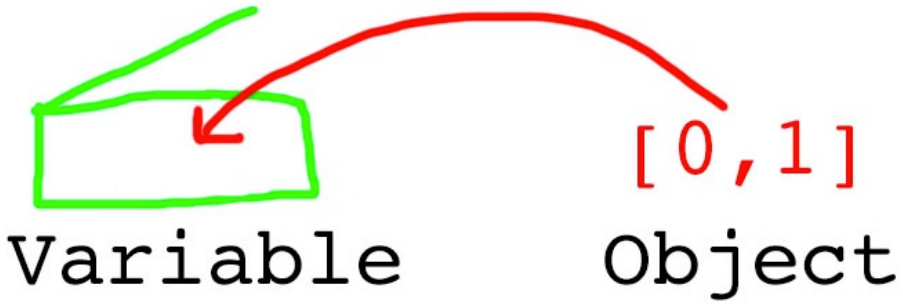
What will happen if the list *lista* is declared as *global*?

Functions

Global and local variables (VI)

Parameter passing in Phyton

- Python is pass-by-object-reference.
  - A variable and an object are different things.
  - A function receives a reference to (and will access) the same object in memory as used by the caller.
  - The function provides its own box and creates a new variable for itself.

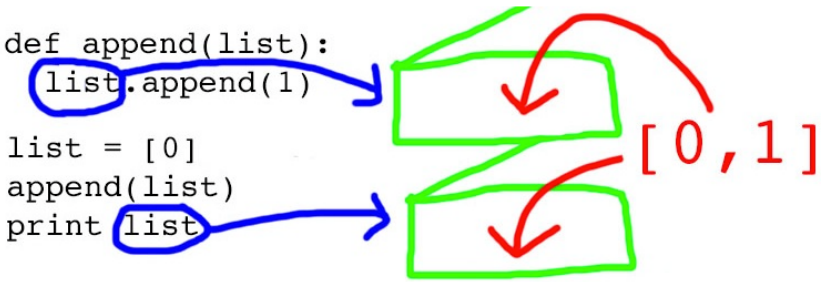


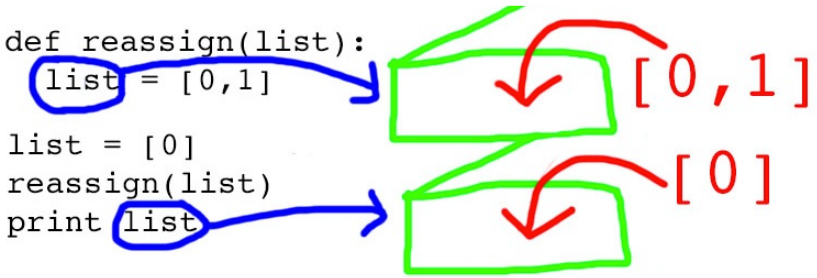
Source

Functions

Global and local variables (VII)

Parameter passing in Phyton





Want to know more? Click here!

Pass-by-object-reference

Object references are passed by value

Functions

Default argument values (I)

Python supports default arguments:

- Poweful and simple feature.
- Simpler (and more flexible) function calls.

```
def ask_ok(prompt, retries=4, complaint="Yes or no"):
    while True:
        ok = input(prompt)
        if ok in ('y', 'ye', 'yes'):
            return True
        if ok in ('n', 'no', 'nop', 'nope'):
            return False
        retries = retries - 1
        if retries < 0:
            raise IOError('refusenik user')
        print(complaint)
```

Functions

Default argument values (II)

New Python features

- The `in` keyword
- Exceptions (error handling)

The function can be invoked in several ways:

- `ask_ok('Do you really want to quit')`
- `ask_ok('OK to overwrite the file?', 2)`
- `ask_ok('OK to overwrite the file?', 2, 'Come on, yes or no!')`

Functions

Keyword arguments

Function arguments can be named:

- It overrides classic positional arguments.
- Order does not matter.
- Positional arguments must be first.

```
def foo(bar, baz):
    print(bar, baz)

foo(1, 2)
foo(baz = 2, bar = 1)
```

```
def foo(bar = "hello", baz = "bye"):
  print(bar, baz)

foo()
foo("hi")
foo(baz = "hi")
```

Arbitrary number of arguments:

- Arguments as `*arg1` and `**arg2`
- Do not worry about it ... right now.

Coding conventions

Documentation strings (I)

Documentation is important:

- Q: Will you remember why did you wrote that crazy code line?
- A: No, so you must document your code.
- A: Yes, no programmer likes documentating his code.

Python provides automatic documentation features:

- It can be accessed with `foo.__doc__` (version 3.X)

```
>>> print(print.__doc__)
print(value, ..., sep=' ', end='\n', file=sys.stdout, flush=
    False)

Prints the values to a stream, or to sys.stdout by default.
Optional keyword arguments:
file:  a file-like object (stream); defaults to the current sys.
    stdout.
sep:   string inserted between values, default a space.
end:   string appended after the last value, default a newline.
flush: whether to forcibly flush the stream.
```

Coding conventions

Documentation strings (II)

Documentation conventions:

- The first line should be a summary.
- The second line should be blank.
- One or more lines with detailed description (arguments, side effects, etc).
- Respect indentation.

```
def my_function():
    """Do nothing, but document it.

    No, really, it doesn't do anything
    """
    pass

print(my_function.__doc__)
```

Coding conventions

Coding style (I)

Make your code easy to read using good coding style.
Python coding style convention:

- 4-space indentation, with no tabs.
- Maximum 79 characters per code line.
- Separate functions and classes with white lines.
- Separate large code blocks with white lines.
- Use docstrings.
- Operators spacing: `a = f(1, 2) + g(3, 4)`.
- Proper use of capitals:
  - Classes: `CamelCase`
  - Methods and functions: `lower_case_with_underscores()`

Want to know more? Click here!

Examples

Example 1: Matrices addition

```
X = [[12,7,3],
     [4 ,5,6],
     [7 ,8,9]]

Y = [[5,8,1],
     [6,7,3],
     [4,5,9]]

result = [[0,0,0],
          [0,0,0],
          [0,0,0]]

# iterate through rows
for i in range(len(X)):
    # iterate through columns
    for j in range(len(X[0])):
        result[i][j] = X[i][j] + Y[i][j]

for r in result:
    print(r)
```

Source

Examples

Example 2: Calculator

```
def add(x, y):
    """This function adds two numbers"""
    return x + y

def subtract(x, y):
    """This function subtracts two numbers"""
    return x - y

def multiply(x, y):
    """This function multiplies two numbers"""
    return x * y

# take input from the user
print("Select operation.")
print("1.Add")
print("2.Subtract")
print("3.Multiply")

choice = input("Enter choice(1/2/3):")
num1 = int(input("Enter first number: "))
num2 = int(input("Enter second number: "))

if choice == '1':
    print(num1,"+",num2,"=", add(num1,num2))
elif choice == '2':
    print(num1,"-",num2,"=", subtract(num1,num2))
elif choice == '3':
    print(num1,"*",num2,"=", multiply(num1,num2))
else:
    print("Invalid input")
```

Source

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